**PHOTOCHEMISTRY IN MOLECULAR CLOUDS: STRUCTURE AND PHYSICAL PROPERTIES OF ORGANIC RESIDUES AND ICE AND SUBLIMATION OF VOLATILE MOLECULES.**

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**Introduction:** Organic materials formed through photochemical reactions in ice in molecular clouds are the potential building blocks of the Solar System and could be the precursor of the organic materials found in extraterrestrial materials. However, the formation and evolution processes of organic matter and their material properties are not yet clearly understood.

**Experiments:** The experimental apparatus (PICACHU; *Photochemistry in Interstellar Cloud for Astro-Chronicle in Hokkaido University*) was developed to simulate the formation and evolution of organic matter in molecular clouds and in protoplanetary disks. A mixture of $H_2O$–$CH_3OH$–$NH_3$ gas ($H_2O$:$CH_3OH$:$NH_3$ = 2:1:1 in typical runs) was deposited on a gold-coated cupper or corundum substrate at ~10 K under irradiation of UV photons. The cryostat and UV lamps were turned off after the deposition of ice for 71 hours, and gas molecules sublimated from the deposits with increasing temperature were analyzed with QMS. In-situ observation of ice during temperature increase was made from a glass window of the vacuum chamber with a stereo microscope. Some organic residues formed after the ice sublimation were re-irradiated with UV photons at a room temperature for 65–235 hours. Residual organic materials were examined with a laser microscope, an atomic force microscope (AFM), FE-SEM, and TEM.

**Results and Discussion:**

*Organic residues.* Organic matter with the room-temperature irradiation consists of aggregates of 10–100 nm-sized particles, which may have textural similarity with aggregates of globule organics found in the matrix of CR2 chondrite NWA 801 [1]. The organic residue without the room-temperature irradiation, on the other hand, tends to show featureless smooth textures. We also found from viscoelasticity measurements that organic matter without the room-temperature irradiation is more viscous and sticky than that with irradiation.

*Ice.* During heating from 10 K, the ice started bubbling at ~65 K, indicating that nucleation and growth of bubbles of volatile species occur in the ice and that the amorphous ice becomes like a supercooled liquid at 65 K.

*Volatile species*. Gas molecules with the m/z of <150 were observed with QMS during temperature increase from 10 K to a room temperature. The extent of gas sublimation showed three peaks at 55-60, 140-150, and 170-180 K, and the peak temperatures seem to correspond to the crystallization temperatures of $NH_3$ and $H_2O$ and the sublimation temperature of $H_2O$. This suggests that desorption of volatile organic molecules from ice-organic mixtures does not occur at their individual sublimation temperatures but at the transformation temperatures of the host ice.

**References:** [1] Hashiguchi M. et al. 2013. Geochim. Cosmochim. Acta 122: 306–323.